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Nanotechnology – New Challenges for Patent Law?

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Abstract

After the advent of IT and genetic engineering, patent law now faces another challenge: nanotechnology. Being a hybrid of chemistry and engineering, nanotechnology holds some peculiarities that cause special problems for patent law. Among these are: the patentability of naturally occurring products; the distinction between compound and apparatus claims; and the patentability of selection inventions. The challenges, however, can probably be overcome by consistently applying existing patent law principles.

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1. Introduction

Emerging in the nineteenth century, with a focus on classical engineering and chemistry, patent law has seen many technological changes and developments. A relatively new field of technology is associated with the term "nano". In order to show its impact on patent law, nanotechnology has to be defined and its peculiarities have to be identified. In this first part of the analysis, two important categories of nanotechnology – active and passive nanotechnology – will also be presented. After the scientific issues have been discussed, the analysis turns to the legal aspects of patenting nanotechnological inventions. Due to its peculiarities, nanotechnology raises special problems concerning some patentability requirements. Among these problems are: the patentability of naturally occurring products; the distinction between compound and apparatus claims; and the patentability of selection inventions. The legal discussion focusses on European patent law.

2. Nanotechnology and its Particularities

2.1 What is Nanotechnology?

Nanotechnology is best defined by its "dwarfishness".[1] It deals with structures measuring less than 100 nanometres (nm) – about a thousandth of the diameter of a human hair.[2] This commonly accepted scientific definition is also reflected in European Classification Y01N, established by the European Patent Office (EPO):

> [...] the term nanotechnology covers entities with a controlled geometrical size of at least one functional component below 100 nanometers (nm) in one or more dimensions susceptible to make physical, chemical or biological effects available which are intrinsic to that size.[3]

There is a dispute over whether – as (for instance) according to the definitions of the EPO and the United States Patent and Trademark Office (USPTO)[4] – structures measuring less than 100 nm in only one dimension are nanotechnology.[5] The

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[1] Νάνος (ancient Greek nanos) means dwarf.

[2] G Hornyak et al, *Introduction to Nanoscience* (Boca Raton: CRC, 2008), at 10; R Kelsall et al, *Nanoscale Science and Technology* (West Sussex, England: Wiley, 2005), at 1; C Poole and F Owens, *Introduction to Nanotechnology* (Hoboken, NJ: Wiley, 2003), at 9. Requiring a size of less than 100 nm in at least two dimensions: U Hartmann, *Nanotechnologie* (München: Elsevier, 2006), at 8; M Köhler and W Fritzsche, *Nanotechnology*, 2nd ed (Weinheim: Wiley-VCH, 2007), at 2. 1 nm = 10^{-9} m = 1 part in a billion of a metre.

[3] ECLA European Classification Y01N, "Nanotechnology", note 1; cf. A Esslinger, "Patenting Nanotechnology Inventions in Europe" (2008) 4 *Nanotechnology Law & Business*, 495-500, at 496.

[4] USPTO Class 977 Nanotechnology, section 1; cf. L Axford, "Patent Drafting Considerations for Nanotechnology Inventions" (2006) 3 *Nanotechnology Law & Business*, 305-308; B Mouttet, "Nanotech and The US Patent & Trademark Office: The Birth of a Patent Class" (2005) 2 *Nanotechnology Law & Business*, 260-263.

[5] See note 2 above.

requirement of such measurements in at least two dimensions seems plausible since, otherwise, even ancient thin layer techniques like gold-beating would fit the definition. If, however, you add – like the EPO and the USPTO – a size-specific effect to the definition requirements,[6] some thin layered structures are excluded anyway. At first glance, it seems a circular argument to include nanostructures' specific effects in the definition of nanostructures. But for legal purposes the restriction to small structures having size-specific effects is at least feasible.

There is also a lower limit to nanostructures: the diameter of single atoms must be between 0.2 nm and 0.6 nm.[7] Like chemical compounds, nanostructures can be described by the position of the single atoms they contain. On the other hand they can also be described - like traditional macrostructures - by defining their shape and extension without showing the single atoms. While nanostructures at the upper limit of the nanoscale contain thousands of atoms, smaller ones can easily be shown using chemical structure formulas. Enzymes, for instance, are naturally occurring nanostructures with an average extension of some nanometres.[8]

2.2 What Makes Nanotechnology Special?

As already suggested, nanostructures have size-specific qualities. Structures measuring less than 100 nm have physical properties due solely to their small size. These properties sometimes completely – and surprisingly – differ from equally shaped macroscopic structures. For example, metallic nanoparticles suspended in liquid have different colours depending on the size of the particles; whereas metal in macroscopic structures looks shiny, the same element gains colour when changed into a powder of nanoparticles.[9] The change of properties between macroscopic and nano-sized objects is called a scale effect.

There is a second, less-known characteristic of nanotechnology: since nanostructures are so small, nanoparticles are subject to a strong Brownian motion (i.e. they move like molecules due to heat). If a nanoparticle was the size of a man, it would move around with the speed of a jet aircraft at room temperature. Single nanostructures can therefore only be observed with a temperature-dependent noise. The effects which nanostructures have at the macroscopic level (like the colour of a nanoparticle

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[6] Some proposed definitions completely discard absolute sizes and only require "scales, where properties differ significantly from those at a larger scale": The Royal Society & The Royal Academy of Engineering, "Nanoscience and nanotechnologies: opportunities and uncertainties" (2004), available at http://www.nanotec.org.uk/finalReport.htm (accessed 4 Feb 09), at 5; likewise G Schmid, "The Nature of Nanotechnology" in G Schmid (ed), *Nanotechnology, Vol. 1: Principles and Fundamentals* (Weinheim: Wiley-VCH, 2008) 3-39, at 3-4.

[7] For practical reasons often 1 nm is used (cf. USPTO Class 977 Nanotechnology, section 1(a): "approximately 1-100 nanometers").

[8] For example, hemoglobin, the red blood dye, consists of four myoglobin subparts. Each of these subparts has an extension of 4.5 nm x 3.5 nm x 2.5 nm: J Berg et al, *Biochemistry*, 6th ed (New York: Freeman, 2006), at 47.

[9] R Johnston, *Atomic and Molecular Clusters* (London: Taylor & Francis, 2002), at 204; U Kreibig and M Vollmer, *Optical Properties of Metal Clusters* (Berlin: Springer, 1995), at 218-226 and 275-371. Even more impressive are the fluorescent colours of semiconductor nanoparticles. On this, see: Hornyak et al (note 2 above) at 31-33.

suspension) are the statistic sum of the behaviour of a great number of single nanostructures.

2.3 Active and Passive Nanotechnology

James Tour introduced an important distinction between different areas of nanotechnology: active and passive nanotechnology. Passive nanotechnology, like the well-known lotus-effect surface, or sunscreens containing nano-sized titanium particles,[10] is characterised by nanostructures whose "presence alone adds a significant increase to the performance of the system". With active nanotechnology, however, "the nano entity does something elaborate when compared to the passive systems". [11] Structures belonging to active nanotechnology thus carry out more complex functions, like accepting and emitting photons or performing movements. The latter is consistent with a common definition of machines, which are characterised as having moving components.[12] Hence, important exponents of active nanotechnology are known as "nanomachines".

Although commercial applicability is still far away in the future,[13] prototype nanomachines like the nanocar already exist. The first version of this car is a complex molecule resembling a car 3 nm long and 4 nm wide with rotating fullerene wheels.[14] The second version is equipped with a molecular motor that is intended to drive the car by paddling motions.[15] As already observed, nature is a large reservoir of existing nanomachines. For instance, F-Type ATPase – a widespread enzyme which converts energy in certain cell organelles – is a naturally occurring nano-sized motor.[16] Future applications of nanomachines range from manufacturing to medicine, but are still difficult to predict.

3. Patenting Nanotechnological Inventions

Research and development of nanotechnology requires a huge amount of investment. It rather resembles chemistry and gene technology, where progress requires substantial investments, and can be contrasted with software development, which can be accomplished by a great number of contributors without commercial interests. In the area of nanotechnology, giving incentives by providing for patents therefore seems to be necessary. This general observation has, however, to be modified when it

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[10] Cf. German Federal Court of Justice, *Kosmetisches Sonnenschutzmittel*, X ZR 68/99 [2002] BGHReport 555 [2003] (BGH).

[11] J Tour, "Nanotechnology: The Passive, Active and Hybrid Sides – Gauging the Investment Landscape from the Technology Perspective" (2008) 4 *Nanotechnology Law & Business*, 361-373, at 362.

[12] Cf. *Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery*, Art 2(a).

[13] Cf. Tour (note 11 above) at 370.

[14] Y Shirai et al, "Directional Control in Thermally Driven Single-Molecule Nanocars" (2005) 5 *Nano Letters*, 2330-2334.

[15] J-F Morin et al, "En Route to a Motorized Nanocar" (2006) 8 *Organic Letters*, 1713-1716.

[16] J Berg et al (note 8 above) dedicate a whole chapter to naturally occurring motors (ch 34, at 977-1000).

comes to naturally occurring substances, which is reflected in the legal problems concerning the distinction between invention and discovery. Even the question of whether compound or apparatus claims – or both of them – are suitable for nanomachines, touches upon the problem of giving the right amount of protection. Finally, in the field of nanotechnology, extensive research may lead to inventions which solely consist of a nanoscale selection from old macroscale patents.

3.1 Naturally Occurring Products

Nanotechnology often draws on blueprints provided by nature, e.g. complex proteins represent naturally occurring nanomachines.[17] Similarly, gene technology provided ways of using newly-discovered (but already existing) genes. Both fields of technology therefore yield fundamental innovations that, if patented, have a potential to monopolise naturally occurring systems and block further development.

Drawing on "inventions" already existent in nature creates problems with several of the patentability requirements. First, the question of whether the innovation is an invention or just a discovery arises (under the European Patent Convention (EPC), Art 52(2)). This question can be answered pretty easily by referring to the patentability of naturally occurring substances. The mere description of such a substance is not a patentable invention but a discovery. If, however, a way of synthesising and/or isolating the substance is found, the discovery becomes an invention.[18] The difference is that the inventor has shown a way of providing the substance instead of merely describing it.

The second problem is novelty (EPC, Art 54). How can a substance already existing in nature be novel? The answer is that novelty depends on the availability of an invention to the public. As long as you are the first to devise a way to provide a substance – i.e. the substance in its pure form – your invention is novel.

Finally, the question of whether such an invention satisfies the requirement of inventive step remains (EPC, Art 56). When naturally occurring substances are artificially modified, and the modification is inventive, patenting the resulting product meets no objections. The same is true for the inventive isolation and synthesis of a newly discovered natural substance. Should, in contrast, the isolation and synthesis of a newly-discovered, naturally occurring substance contain no inventive steps – and should the requirement only be fulfilled by the new and surprising effects of the substance – patentability seems to be an unnecessary incentive.

With nanotechnology, this problem becomes even more acute, since naturally occurring substances can be highly complex nanomachines at the same time. Patenting these substances would be like patenting pre-existing machines. Nevertheless, rejecting new effects as a sufficient cause for inventiveness would be contrary to the EPO practice regarding the protection of substances: the inventive step for a product patent on substances can be fulfilled by new and surprising effects of the

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[17] This touches a new field of biology called "Synthetic Biology". See: G Wolbring, "Bio-tech, NanoBio-Tech, SynBio-tech, NanoSynBio-tech? The changing face of biotech law" (2007) 4 *Journal of international Biotechnology Law*, 177-186 (Part I), 221-226 (Part II).

[18] Cf. *Directive 98/44/EC of the European Parliament and of the Council of 6 July 1998 on the legal protection of biotechnological inventions*, Art 3(2); G Zekos, "Nanotechnology and Biotechnology Patents" (2006) 14 *International Journal of Law and Information Technology*, 310-369, at 369.

substance.[19] Patenting is therefore possible, even if the mere making available of the substance is not inventive. The only caveat is – due to the novelty requirement – that the substance has not been previously available to the public. This applies to both newly-synthesised and naturally occurring substances.[20]

Should the line between patentable invention and non-patentable discovery accordingly be redefined? The answer is no, but patentability of naturally occurring substances has to be considered. As with gene patenting, the newly occurring problems might be a chance to readjust legal practice in relation to the patenting of naturally occurring substances. Product protection should only be allowed if the synthesis or isolation of a substance is inventive. This is possible without changing the law. On the contrary, it would mean a re-establishment of the line between invention and discovery – which has arguably been blurred by the current practice with regard to the patenting of natural substances. Should a substance - or a more complex system - have unexpected effects, use patents would still be available.[21]

3.2 Compound versus Apparatus Claims

Patent law distinguishes between compound and apparatus claims. Compounds may be substances like potassium nitrate or compositions like black powder. In contrast, apparatus claims apply to machines like, for example, a steam engine. Both of them are patentable products, but they are sometimes treated differently – for example with regard to the patentability of already-known compounds by reason of medical indications according to EPS, Arts 54(4) and 54(5). Nanotechnology blurs the line between these two.[22] A compound is defined by having its distinctive properties independently of its shape.[23] Within this definition, shape is traditionally restricted to the supramolecular level. It does not, therefore, cover structures composed of single atoms. Chemical substances, of course, have a certain molecular structure, but they are substances nevertheless.

Nanomachines, in contrast, often can be specified as complex molecular structures, but, at the same time, they are regarded as very small machines. Sometimes their description as traditional machines fails due to scaling effects. Should they be treated as a compound or as machines? The best answer is that it depends on what the

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[19] *Triazol*es*/AGREVO*, T 939/92 [1996] OJ EPO 309 (EPO); cf. S Féaux de Lacroix, “Wann machen überraschende Eigenschaften erfinderisch?” 2006 *Gewerblicher Rechtsschutz und Urheberrecht*, 625-630; B Jestaedt, “Artikel 56 Erfinderische Tätigkeit“ in G Benkard (ed), *EPÜ* (München: CH Beck, 2002), at margin number 141. An instructive example is the decision of the German Federal Court of Justice, *Kosmetisches Sonnenschutzmittel*, X ZR 68/99 [2002] BGHReport 555 [2003] (BGH). There, the mixture of two sun protecting agents (one of them consisting of nanoparticles) with different radiation absorption maxima was not held to be inventive if the new effect was simply the sum of the two absorption spectra.

[20] Cf. R Moufang, “Patentfähige Erfindungen (‘patentable inventions’)” in R Schulte (ed), *Patentgesetz mit EPÜ*, 8th ed (Köln: Heymanns, 2008), at margin number 325.

[21] A detailed analysis of the problem will soon be given by Ralf Uhrich, PhD candidate at the DFG Graduate School, in “Intellectual Property and the Public Domain” at the University of Bayreuth.

[22] R Uhrich and H Zech, “Patentierung von Nanomaschinen – Stoffschutz versus Vorrichtungsschutz” 2008 *Gewerblicher Rechtsschutz und Urheberrecht*, 768-771.

[23] K Bacher and K-J Melullis, “PatG” in G Benkard (ed), *Patentgesetz*, 10th ed. (München: CH Beck, 2006), at margin number 39a; cf. R Moufang (note 20 above) at margin number 214.

patentee has applied for. If a nanomachine is described as an apparatus, there is no need to treat it as a compound. If, however, it is described as a compound (e.g. using a chemical formula) the invention can be treated as such. The rules on, for example, second medical use would apply. Moreover, it should be regarded as legitimate to claim both kinds of protection by drafting the patent application using both methods of description. Only by allowing for this accumulation of claim categories can the inventor get the full return on his invention.

3.3 Selection Inventions

Nanostructures with new properties can come within the scope of protection of old patents describing macrostructures which do not have the respective nanoeffects. This raises questions concerning the patentability of such nanostructures:[24] is the selection of a small range of size (the nanoscale) within a range of perhaps ten thousand times larger novel? Is it inventive? Shall the old patent be limited in scope?

Whereas the scope of a patent is not subject to European patent law, the questions of novelty and inventive step are. The EPO generally admits patents for selection inventions under certain conditions:

> A fairly broad range of numbers delimited by minimum and maximum values (in the case 0 and <100 mol%) does not necessarily represent a disclosure, ruling out the selection of a sub-range, of all the numerical values between these minimum and maximum values if the sub-range selected is narrow (in this case, 0.02-0.2 mol%) and sufficiently far removed from the known range illustrated by means of examples (in this case 2-13 mol%).
>
> The sub-range is novel not by virtue of an effect which occurs only within it; but this effect permits the inference that what is involved is not an arbitrarily chosen specimen from the prior art but another invention (purposive selection).[25]

The critical patentability requirement is novelty. A pre-existing disclosure of a broad range of numbers is no obstacle if the sub-range selected is: (1) narrow (2) sufficiently far from illustrated examples; and (3) capable of giving rise to the inference of a novel effect. Nanotechnological inventions relying on scale effects fit this definition exactly. If their surprising effects can fulfil the inventive step requirement, patentability is given. When it comes to scale effects, this also seems to be consistent with the

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[24] C Germinario, "Can nanotech patenting learn from the past biotech experience?" (2006) 181 *Patent World*, 27-29, at 27; S Huebner, "Zur Neuheit von Erfindungen aus der Nanotechnologie" 2007 *Gewerblicher Rechtsschutz und Urheberrecht*, 839-840; cf. M Schauwecker, "Nanotechnologische Erfindungen im US-amerikanischen Patentrecht" 2009 *Gewerblicher Rechtsschutz und Urheberrecht Internationaler Teil*, 27-37, at 28-30.

[25] *Thiochloroformates/HOECHST*, T 198/84 [1985] OJ EPO 209 (EPO); cf. M Franzosi, "Novelty and Non-Obviousness – The Relevant Prior Art" (2000) 3 *Journal of World Intellectual Property*, 683-695, at 686-687; R Rogge, "Gedanken zum Neuheitsbegriff nach geltendem Patentrecht" 1996 *Gewerblicher Rechtsschutz und Urheberrecht*, 931-940, at 938-940; G Szabo, "Problems Concerning Novelty in the Domain of Selection inventions" 1989 *International Review of Industrial Property and Copyright Law*, 295-302.

incentive paradigm of patent law: nanotechnology shows us how important incentives (even for inventing by selecting or by better scaling) are.

Despite this, some national courts – like the German Federal Court of Justice[26] – generally reject selection patents for lack of novelty. This leads to the strange result that a selection invention may be inventive due to a surprising new effect, but nevertheless unpatentable due to existing prior art.[27] It is not only with regard to nanotechnology that the EPO's view is preferable. If a selection is inventive in itself, there is no reason why this advancement should not be patented. The resulting patents can, of course, depend upon pre-existing broad-range patents. Dependency ends when the old patents expire. This seems to be a fair balance of interests.

4. Conclusions

Nanotechnology holds challenges for patent law. Some of these are new – as with the need for a more precise compound definition. Others are, however, old – as with the invention versus discovery problem. All of these challenges can, however, be overcome by consistently applying existing legal principles. At this point, amending the law seems unnecessary.

[26] *Crackkatalysator I*, X ZB 10/88 [1990] 111 BGHZ 21 (BGH).

[27] S Huebner, *ibid*, at 839-840.